Problematic eating behaviors and psychopathology in patients undergoing bariatric surgery: the mediating role of loss of control eating

RUNNING TITLE: LOSS OF CONTROL AND EATING BEHAVIORS

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Abstract

Objective: This study compares different problematic eating behaviors (PEBs; objective(OBE)/subjective(SBE) binge-eating and compulsive (CG)/non-compulsive (NCG) grazing) in relation to the severity of loss of control (LOC) and psychopathology. We also investigate LOC as a mediator between PEBs and psychopathology. **Methods**: This cross-sectional study assessed a group of patients before bariatric surgery (n=163), and a group of bariatric patients 12 months or more after surgery (n=131). Face-to-face assessment: Eating Disorders Examination for binge-eating episodes; Rep(eat) for grazing. LOC was measured by 5 questions answered in a 5-point Likert scale. Self-report measures: disordered eating, grazing, negative urgency, depression, anxiety, and stress. **Results**: OBEs were reported by 26(8.8%), SBE by 29(9.8 %), CG by 35(11.9%), and NCG by 36(12.2%) of patients. The different PEBs differed significantly in the severity of LOC ($F(3,120)= 25.81$, $p<.001$). Patients reporting OBEs scored higher and patients with NCG scored lower in most measures than patients with other PEBs. Patients with any PEBs scored higher in all self-report measures than those not reporting any PEBs, with statistical significance reached for uncontrolled eating ($F(4,288)= 20.21$, $p<.001$), emotional eating ($F(4,288)= 23.10$, $p<.001$), repetitive eating $F(4,288)= 18.34$, $p<.001$), and compulsive grazing ($F(4,288)= 27.14$, $p<.001$). LOC was found to be a full mediator between PEBs and psychopathology. **Discussion**: There is no evidence that the different PEBs differ in the psychopathology severity, independently of the experience of LOC eating during the eating episodes. We show evidence for the conceptualization of different PEB, including grazing, on a continuous scale of LOC and psychopathology.

Keywords – loss of control eating; binge-eating episodes; grazing; eating-related psychopathology; bariatric surgery

INTRODUCTION

Binge eating is considered a central marker in the diagnosis of bulimia nervosa or binge-eating disorder. The DSM-5 (American Psychiatric Association, 2013) defines binge-eating episodes based on two criteria: 1) the experience of loss of control (LOC) over eating during the episodes, a sense that one cannot resist eating or stop eating once started; and, 2) the ingestion of an extremely large amount of food. However, a growing body of research has put into question the importance of the amount of food consumed during the episode, arguing that the experience of LOC is uniquely and more strongly related with psychopathology than the amount ingested, being the core feature in the definition of binge eating (Fitzsimmons-Craft et al., 2014; Goldschmidt, 2017; Mond, Latner, Hay, Owen, & Rodgers, 2010). LOC eating has been associated with poor quality of life, problematic weight control behaviors, low self-esteem, disinhibition while eating, emotional dysregulation, depressive symptoms and general distress in non-clinical population (Goldschmidt et al., 2015; Jenkins, Conley, Hoste, Meyer, & Blissett, 2012), and in patients with eating disorders or obesity (Blomquist et al., 2014; Colles, Dixon, & O'Brien, 2008b; Fitzpatrick et al., 2014). Furthermore, the experience of LOC seems to be more resistant to treatment than the amount of food eaten. For instance, although LOC eating with large amounts of food seem to decrease significantly in the initial stages of treatment (Niego, Pratt, & Stewart Agras, 1997), or as a result of self-monitoring (Hildebrandt & Latner, 2006), the experience of LOC eating with modest amounts remains high (Hildebrandt & Latner, 2006) and changes more slowly during treatment (Niego et al., 1997). LOC eating in pediatric ages frequently seems to persist into early adolescence being associated with the onset of binge-eating disorder (Tanofsky-Kraff et al., 2011) and is a unique prospective predictor of overweight/obesity and depressive syndromes (Sonneville et al., 2013).

Grounded on this accumulating evidence highlighting the clinical importance of LOC eating regardless of the amount ingested, a rising number of studies have used a terminology proposed by Fairburn, Cooper & O'Connor (2014) who distinguish objective binge-eating episodes (OBE – experience of LOC while eating objectively large amounts of food) from subjective binge-eating episodes (SBE – experience of LOC while eating an amount of food that is not large but is experienced as excessive by the respondent). The current state of the art suggests that among patients with an eating disorder, SBEs are associated with significant clinical impairment similar to OBEs (Brownstone et al., 2013; Mond et al., 2010; Palavras, Morgan, Borges, Claudino, & Hay, 2013). Evidence shows that the size of binge-eating episodes does not differentiate the degree of eating disorder psychopathology, dietary restraint, disinhibition, hunger, mental health or general psychopathology (Brownstone et al., 2013; Keel, Mayer, & JH, 2000; Latner, Hildebrandt, Rosewall, Chisholm, & Hayashi, 2007; Mond et al., 2010), leading to the proposal that both SBE and OBE should be considered in the diagnoses of bulimic disorders (Goldschmidt, 2017).

In addition to being a hallmark feature for eating disorders, it is estimated that binge-eating episodes are reported by about 50% of the general population that do not meet criteria for an eating disorder (Machado, Machado, Gonçalves, & Hoek, 2007), and in up to 40% of the bariatric surgery candidates with severe obesity (Colles et al., 2008b), being associated with increased caloric intake and higher BMI (Masheb et al., 2015; Meany, Conceição, & Mitchell, 2014; Mustelin, Bulik, Kaprio, & Keski-Rahkonen, 2017). Binge-eating episodes, regardless of the amount of food ingested, have also been associated with greater eating disorder and general psychopathology, as well as poorer quality of life in diverse obese groups, and with poor weight loss outcomes in patients after bariatric surgery (Blomquist et al., 2014; Meany et al., 2014;

White, Kalarchian, Masheb, Marcus, Marsha, & Grilo, 2010). The amount of food eaten, however, seems to be associated with the severity of LOC experienced (Mitchell et al., 2012) and considered more of a risk factor for poor weight management (Goldschmidt, 2017). Put together, these data highlight the importance of assessing the experience of LOC independently of the quantity consumed and its conceptualization as a marker of psychopathology.

More recently, research has suggested that LOC eating may be associated with other problematic eating behaviors (PEBs) besides binge eating (Conceição, Utzinger, & Pisetsky, 2015). Studies with patients undergoing bariatric surgery for weight loss brought into light grazing behavior, generally characterized as the ingestion of food in an unplanned and repetitive manner, not in response to hunger/satiety sensations. Grazing behavior has been consistently associated with poor weight loss (Colles, Dixon, & O'Brien, 2008a; Conceição et al., 2017; Robinson et al., 2014) and weight regain (Kofman, Lent, & Swencionis, 2010; Pizato, Botelho, Gonçalves, Dutra, & Carvalho, 2017), following bariatric surgery. Despite mixed findings (Conceição et al., 2014), growing evidence supports its association with LOC eating (Goodpaster et al., 2016), increased eating disordered psychopathology, psychological distress, impulsivity under negative emotions, uncontrolled eating and emotional eating (Conceição et al., 2017), lower dietary restraint and higher dietary disinhibition (Colles et al., 2008a) in both bariatric and community samples. The non-planned nature of this eating behavior and its compulsive component suggest that there is little control exerted over eating and that some degree of lack of control is associated (Conceição et al., 2014). With different definitions being used in the literature, Conceição and colleagues (2014) made an attempt organize the varied criteria used across studies, and proposed a consensus definition considering two types of grazing: non-compulsive grazing, characterized by a

distracted and mindless repetitive eating; and a compulsive grazing, characterized by not being able to resist going back to eat repeatedly. A grazing-type behavior has been reported by 33% of patients after bariatric surgery (Goodpaster et al., 2016), 57.6% of patients with bulimia, 34.3% with anorexia and 44% with binge-eating disorder (Conceição et al., 2013).

Based on this evidence, Conceição et al. (2015) proposed that these different PEBs – OBEs, SBEs, compulsive and non-compulsive grazing – should be conceptualized in relation to different degrees of LOC eating, with OBE and non-compulsive grazing being associated with the highest and lowest severity of LOC eating, respectively. Yet, support for the conceptualization of these different PEBs on a continuum of LOC eating and psychopathology is still limited (Goldschmidt et al., 2016). Moreover, there is little evidence for the two subtypes of grazing or for a conceptualization of grazing in the spectrum of disordered eating.

This study compares these different PEBs in relation to the severity of LOC eating and psychopathology. We also investigate the role of LOC eating as a mediator between PEBs and psychopathology. With this study, we aim to provide evidence that the different PEBs are associated with different severity of LOC eating and that, regardless of the PEB, the experience of LOC eating during the episode is the core feature explaining the associated psychopathology. Additionally, we wish to provide further evidence for the concept of grazing in the spectrum of disordered eating psychopathology.

METHODS

Procedure and sample

A total of 309 bariatric surgery patients were invited for this study, but 15 denied participation claiming no interest (n=5), or no time for the assessment (n=10). This cross-sectional study assessed a convenience sample of 163 bariatric surgery candidates and 131 postoperative bariatric patients (12 months or more following surgery; M= 26.32; SD=10.18; min=12; Max=58). Between November 2015 and April 2017 patients were invited to the study after their appointment with a professional of the bariatric surgery's multidisciplinary team in two main hospital centers in the North of Portugal. Eligible patients included those cleared out for bariatric surgery by the multidisciplinary team. Bariatric candidates with any major active psychiatric disorder (including binge-eating disorder), evaluated by the psychiatrist of the bariatric team, would not receive approval for surgery. Specific exclusion criteria for this study included: current pregnancy or breastfeeding; not being able to understand/read Portuguese; not being autonomous in eating choices. Patients accepting participation in this study were interviewed by a trained psychologist, and responded to a set of self-report measures.

Patients were informed about the confidentiality of the data collected and that the information discussed would not influence the treatment provided. An informed consent form was signed by those accepting participating in our study. This study was approved by the institutional review boards of the university and hospital institutions involved and conforms to the recognized standards of the Declaration of Helsinki.

Face-to-face psychological assessment: Interviews were conducted by three psychologists trained in the assessment measures used. All diagnoses were discussed for consensus. Socio-demographic and anthropometric information was retrieved. Weight

and height were measured during the medical appointment. The diagnostic items of the *Eating Disorders Examination, 17th Ed*, (Fairburn, Christopher G Cooper & O'Connor, 2014) were used to identify OBEs and SBE, as defined in the introduction section. The *Rep(eat)* interview (Conceição et al., 2014, Appendix B) was used to identify grazing in its compulsive and non-compulsive subtypes, as defined in the introduction section. Both the EDE and the Rep(eat) are investigator-based interviews where the interviewer decides on the presence/absence of episodes after a series of compulsory and subsidiary probe questions. For the purpose of this study, the interview focused on the preceding four weeks.

To assess the *experience of loss of control* associated with the different PEBs, when one of these behaviors was reported by the participant, the interviewer would follow with five questions regarding the experience of LOC during each specific episode. The questions were answered orally by the participant in a 5-point Likert scale from 0 (not at all) to 4 (extremely). The interviewer prompted the questions asking: "*During the times where you experience […*description of the episodes*…], while you were eating, to what extent did you*: i) …feel a sense of LOC?; ii) …feel that you could not stop eating once you started?; iii)… did you feel that you overate?; iv)… did you feel that you could not resist eating?; v)… did you feel driven or compelled to eat? These five questions were retrieved from Ecological Momentary Assessment studies [e.g. Goldschmidt et al. (2011)] that assessed the experience of LOC eating associated with each binge-eating episode. Cronbach's α for the sum of the 5 questions was >.90 for the different PEBs.

Self-report measures: The *Eating Disorders-15* (ED-15; Tatham et al., 2015) is a 15-item measure that assesses eating disorder psychopathology and compensatory

behaviors. It generates a total score and two subscales: weight and eating concern. Cronbach's α for our sample was .89 for the total score. The Portuguese version of the *Three Factors Eating Questionnaire-Revised 21*(TFEQ-R21; Cappelleri et al., 2009; Moreira, Almeida, Sampaio, & Almeida, 1997) was used. This is a 21-items revision of the Stunkard and Messick questionnaire (Stunkard & Messick, 1985) that generates three subscales: uncontrolled eating; restraint eating and emotional eating. For the mediation analyses, we have computed a total score (TFEQ_sum) corresponding to the sum of the different subscales. Cronbach's α for our sample was .85 for the total score. The Rep(eat)-Q (Conceição et al., 2017) is a 12-item measure validated in Portuguese that assesses a grazing-type eating pattern. It generates two subscales: repetitive eating and compulsive grazing, and a total score. Cronbach's α for our sample was .93 for the total score. The negative urgency subscale of *the Urgency, Premeditation, Perseverance, and Sensation Seeking scales* (UPPS-NU; Whiteside, Lynam, Miller, & Reynolds, 2005) is a 12-item measure that assesses the tendency to act impulsively under negative emotions. Cronbach's α for our sample was .91. The Portuguese version of the *Depression, Anxiety and Stress Scales* (DASS; Lovibond & Lovibond, 1995; Pais-Ribeiro, Honrado, & Leal, 2004), a 21-item measure, was used. For the mediation analyses, we have computed a total score (DASS_sum) corresponding to the sum of the different subscales (depression, anxiety, and stress). Cronbach's α for our sample was .96 for the total score.

Statistics

One way ANOVA was used to compare eating behaviors in term of their scores on LOC eating, and MANOVAs to compare patients presenting the different PEBs (IV) on the psychological measures used (DV). The Sidak post hoc test for pairwise comparison was used to test the difference between each possible pair of PEBs while

controlling for familywise error rate. We have further used Ryan-Einot-Gabriel-Welsch (REGWF) post hoc test, a powerful step-down test that keeps familywise error at α. REGWF generates homogeneous subsets where the means that saturate in each resulting subset are not significantly different, highlighting the similarities within each subset. When patients presented more than one PEB they were assigned to the group of the PEB found to be associated with the highest severity of LOC eating in the previous analysis. This set of analyses was conducted controlling for the co-variable "sex". Since the co-variable "pre-/post-surgery" was non-significant and showed the exact same pattern of significances it was removed from the model. These analyses were conducted with IBM SPSS 22 software. Variations in sample size are due to missing data.

Mediation analyses were used to investigate the variance in the relationship between an independent variable (IV; PEB) and a dependent variable (DV; psychopathology), that is better explained by a third variable (Mediator; LOC eating).

Acknowledging the cross-sectional nature of our sample, different authors suggested that the mathematical methods underlying mediation analyses can be employed with such data, particularly when there is a solid argument in the field suggesting the causal relationships among the variables under study (see Hayes (2013), pp.78-91). As discussed in the introduction section, we have sufficient evidence to support such analysis. Notwithstanding, our results will be discussed in light of the nature of our data.

In the models tested, the IV (a multicathegorical variable) represents patients presenting no PEBs, non-compulsive grazing, compulsive grazing, SBE or OBE. Three models were tested for three different DV reflecting eating-related psychopathology (TFEQ_sum and ED-15) and psychological distress (DASS_sum). The macro PROCESS for SPSS was used with model 4, bootstrapping of 5.000, bias corrected as

the bootstrap confidence interval (CI) method, 95% CI, and Helmert coding method (see Hayes (2013), pp.568). The contrasts tested with Helmet coding allow the comparison of a group *x* to all groups ordinally higher on the categorical variable. In our models, *path 1* represents the comparison between no PEB and any PEB; *path 2* non-compulsive grazing vs compulsive grazing, SBE and OBE; *path 3* compulsive grazing vs SBE and OBE*;* and, *path 4* SBE and OBE.

RESULTS

Characterization of the Sample

Out of the 294 participants of our study, 247 (84%) were women and 47 (16%) men. Participants were aged between 19 and 67 (M=42.02, S.D=10.78), the majority (63.9%) was married or living with a partner, had at least 9 years of education (63%) and was employed (56.8%). OBEs were reported by 26(8.8%), SBE by 29(9.8%), compulsive grazing by 35(11.9%), and non-compulsive grazing by 36(12.2%) of the patients. **Table 1** presents the detailed sociodemographic information and the distribution of PEB pre- and post-surgery.

(*Insert Table 1 about here*)

Differences in LOC eating and psychopathology between the different PEBs

The varied PEBs differed significantly in the severity of LOC experienced during the eating episode, with non-compulsive grazing being associated with the lowest and OBEs with the highest severity. OBEs were associated with significantly higher severity of LOC eating than both grazing subtypes. (**Table 2**) REGWK homogeneous subsets supported the assumption that no significant differences were

found in the LOC scores between OBE and SBE, or between SBE and compulsive grazing.

Patients with any PEBs scored higher in all self-report measures than those not reporting any PEBs, with statistical significance reached for uncontrolled eating, emotional eating, repetitive eating and compulsive grazing subscales of the Rep(eat)-Q. Patients reporting OBEs and non-compulsive grazing scored higher and lower in most subscales, respectively, than other patients with PEBs (with the exception of eating concern and repetitive eating). Nonetheless, OBE, SBE, and compulsive grazing saturated in the same REGWF homogeneous subset for uncontrolled eating, emotional eating, weight concern and negative urgency. As for the grazing measure (Rep(eat)-Q), not only patients reporting compulsive and non-compulsive grazing but also patients reporting OBE and SBE scored significantly higher than patients not reporting PEBs. No significant differences were found for cognitive restraint.

In regard to depression, anxiety, and stress, although patients reporting OBE were the only ones scoring significantly higher than patients without PEBs, it is noticeable that patients with any PEB saturated together in a REGWF homogeneous subset for depression, anxiety and stress, highlighting their similarities in the psychological distress associated.

Finally, the same PEB frequently saturated in different REGWK subsets within the same measure. For instances, in regards to uncontrolled eating, compulsive grazing and SBE saturated in one subset together with non-compulsive grazing, and in another subset with OBE, suggesting that they occupy a median position within the spectrum of uncontrolled eating.

(*Insert table 2 about here*)

The mediating role of LOC eating in understanding psychopathology in PEBs

LOC was found to be a mediator between PEBs and psychopathology [**Figure 1a)**: disordered eating (TFEQ_sum); **Figure 1b)**: eating disorder psychopathology (ED-15 total score); **Figure 1c)**: psychological distress (DASS_sum)]. Overall, supporting our data presented in **Table 2**, non-compulsive grazing, compulsive grazing, SBE, and OBE are significantly associated with increasing severity of LOC eating (*a'* path values all positive and significant). Independently of the PEB reported, participants experiencing higher severity of LOC eating scored significantly higher in the psychopathological measures tested (*b* path positive and significant). There is no evidence that the different PEBs differ in the psychopathology severity, independently of the experience of LOC eating during the eating episodes (*c'* paths and omnibus test – relative direct effect – not significant). The presence of PEBs is associated with psychopathology through the level of LOC eating experienced during such episodes which, in turn, is associated with increased psychopathology (*ab* paths and omnibus test – relative indirect effect – with all CIs above zero). Of note, although the omnibus test of the relative total effect (ab + c') was significant for the three models tested, there was not a significant difference between patients reporting compulsive grazing or binge-eating episodes in the total effect explaining psychopathology, suggesting a similarity in these mechanisms of psychopathology between these PEBs.

Discussion

This study expands the current literature supporting the clinical significance of LOC eating by considering other forms of problematic eating beyond SBE and OBE, specifically grazing subtypes, and showing evidence for their association with LOC

eating and psychopathology. This was the first study to compare these different PEBs in terms of the severity of the LOC experienced during the eating episode and the associated psychopathology. Moreover, we provide evidence for the experience of LOC eating as a unique indicator of disordered eating-related psychopathology in a non-eating disordered sample.

LOC eating in association with different PEBs

Taking together the differences found in LOC eating scores across the different PEBs and the results of the mediation models tested (Paths a'), we show evidence for a conceptualization of non-compulsive grazing, compulsive grazing, SBE and OBE as associated with increasing severity of LOC eating as proposed by Conceição et al. (2015). With OBE and non-compulsive grazing associated with the highest and lowest severity of LOC eating, respectively, our data also highlight the similarities in the experience of LOC eating between SBE and compulsive grazing.

PEBs and psychopathology

Generally, patients reporting OBEs and non-compulsive grazing scored highest and lowest, respectively, in the psychopathology measures. Moreover, patients reporting OBEs, SBEs and compulsive grazing showed similar scores in uncontrolled eating, emotional eating, weight concern and negative urgency (same homogeneous subsets). These findings underscore their similarities in these aspects of disordered eating and in the tendency to act impulsively under emotionally negative situations. Further evidence for the similarities between compulsive grazing and binge-eating episodes was found in the mediation analyses where we did not find a significant relative total effect of compulsive grazing explaining psychopathology between both binge-eating episodes. Taken together, these data suggest that compulsive grazing is associated with similar

severity of disordered eating psychopathology to binge-eating episodes (particularly SBEs). Past research has stressed the similarities between SBE and OBE (Fitzsimmons-Craft et al., 2014; Goldschmidt, 2017; Mond et al., 2010) and with this study, we bring attention to compulsive grazing behavior as a clinically relevant eating behavior in the spectrum of disorder eating.

Finally, patients reporting any PEBs scored significantly higher than those not reporting any PEB for uncontrolled eating, emotional eating, repetitive eating and compulsive grazing. Moreover, although the different eating behaviors loaded together in homogeneous subsets for most of the subscales assessed, highlighting their similarities, they also saturated simultaneously in multiple subsets of increasing psychopathology. Additionally, the mediation models show that, compared to patients not reporting PEBs, the presence of any PEB is associated with significantly higher scores in the psychological measures tested. Taken together, these findings support the argument for the conceptualization of these different PEBs in the spectrum of disordered eating psychopathology and psychological distress, as suggested in previous research (Conceição et al., 2017, 2015). Of note, in line with findings from other studies (Fitzsimmons-Craft et al., 2014), cognitive restraint does not differentiate patients reporting the different PEB. As this is a sample undergoing treatment for obesity, it is not surprising that all these patients would have similar concerns about watching their eating.

Grazing behavior and psychopathology

The fact that patients presenting any PEB scored significantly higher than patients without PEBs in the repetitive eating and compulsive grazing subscales, suggests that grazing-type eating behaviors are associated with any PEB. The Rep(eat)-Q assesses a repetitive eating pattern and compulsive grazing-type eating behaviors

(associated with LOC eating). The repetitive eating score was lowest for those not reporting PEB and for SBE (characterized by eating small amounts of food in one sitting with the sense of LOC). The compulsive grazing subscale reflects the sense of LOC eating associated with the eating behavior (ex: "I cannot resist eating in between meals"). Thus it is not surprising that patients reporting OBE and compulsive grazing score the highest in this subscale. Our results also contribute to the clarification of the mixed literature regarding grazing-type eating behaviors and psychopathology. The fact that studies used a variety of definitions to identify grazing-type behaviors (Conceição et al., 2014), diverting particularly in its association with LOC eating, complicated the literature. The majority of studies that did not find an association with psychopathology generally used definitions that would exclude the sense of LOC eating associated with grazing-like behaviors (Masheb, Roberto, & White, 2013; Reas, Wisting, Kapstad, & Lask, 2012), while those which found an association generally did not exclude a sense of LOC in their definition (Busetto et al., 2005; Poole et al., 2005; Robinson et al., 2014). Goodpaster et al. (2016) showed that LOC eating in association with grazing is particularly linked to anxiety disorders, binge-eating disorder and internalizing dysfunction compared to grazing without LOC. We showed that compulsive grazing is associated with higher severity of LOC eating and psychopathology than non-compulsive grazing, which is further evidence that LOC eating plays a central role in explaining psychopathology in PEBs. Future research should explore the role of the grazing subtypes in the context of eating disorders and of obesity treatment.

LOC eating as an indicator of psychopathology

Past research has shown that the presence of LOC eating while eating is associated with increased psychopathology in patients with eating disorders (Fitzsimmons-Craft et al., 2014; Mond et al., 2010), obesity (Colles et al., 2008b), or in

community samples (Latner et al., 2007). We hypothesized that, regardless of the amount eaten or the behavioral presentation of the problematic eating episodes, the severity of LOC eating experienced would explain eating disorder psychopathology and psychological distress. The mediation models tested found support for the severity of LOC eating as a mediator in the relationship between eating behaviors and disordered eating (TFEQ-R21), eating disorder psychopathology (EDE-Q), and psychological distress (DASS). In fact, we found no evidence that the different PEBs differ in the psychopathology severity, independently of the severity of LOC eating. Accordingly, other authors have suggested that the amount of food ingested should be considered a descriptive indicator of the degree of LOC eating (Wolfe, Baker, Smith, & Kelly-Weeder, 2009), and a marker of risk for excess weight gain and obesity (Goldschmidt, 2017). For instance, Mitchell et al. (2012) found that the severity of LOC during OBEs varies in a sample of patients with bulimia nervosa and that greater LOC is associated with a larger amount of kilocalories consumed as well as a greater likelihood of vomiting after an eating episode. These findings bring further support for the argument that assessing LOC eating in a continuous manner rather than dichotomously would allow the identification of a variety of clinically relevant disordered eating behaviors (Conceição et al., 2014; Goldschmidt et al., 2016; Latner, Mond, Kelly, Haynes, & Hay, 2014; Mitchell et al., 2012). Additionally, assessing LOC eating instead of the behavior itself seems to better explain severity of psychopathology. In this context, two measures have been developed to capture de multi-dimension of LOC eating: Loss of Control over Eating Scale (LOCES; Latner et al., 2014), and the Eating Loss of Control Scale (ELOCS; Blomquist et al., 2014). In accordance to our data, it has been suggested that investigating higher order (latent) constructs, instead of specific behaviors/disorders, allows a better understanding of the variability observed in psychopathology or

treatment outcomes (Marek, Ben-Porath, & Heinberg, 2016). The same authors suggested that LOC eating, which may be reflected in different behavioral forms depending on its severity, is a manifestation of the higher order construct disinhibition/disconstraint. Thus research focusing on higher order dimensions of psychopathology instead of on the specific behavioral manifestation may yield a more consistent explanation for psychopathology.

We should stress that our population includes patients reporting PEBs but not meeting full criteria for an eating disorder diagnosis. Our results should not be generalized to other populations and future research should attempt to replicate these findings in other samples (eating disorders, obese non-bariatric, and non-clinical community). We would expect that the difference in terms of LOC eating between these episodes would be more marked in a sample of individuals with bulimic disorders. However, we would not expect much differentiation in terms of psychopathology, nor a full mediation effect of LOC, considering the bias of the disorder itself which is maintained and modulated by a series of mechanisms (such as compensatory behaviors, low BMI, clinical perfectionism, weight-based self-esteem, etc..) that contribute to the psychological state of the individual. In fact, the lack of differences in binge-eating severity, compensatory behaviors, self-esteem, depressive symptoms, or in disordered eating psychopathology reported by previous studies comparing patients with bulimia with OBE vs SBE (Fitzsimmons-Craft et al., 2014; Palavras et al., 2013) may be due to the core psychopathology of the eating disorder. The fact that this study compares eating behaviors reported by individuals that do not meet criteria for an eating disorder allow us to investigate the unique contribution of LOC eating and of the eating behaviors to psychopathology.

Another limitation is that, although we have a large sample size of individuals undergoing bariatric surgery, only a small percentage reported PEBs, which results in a low sample size to detect statistically significant differences between groups for such a large amount of pairwise comparisons tested. The major strengths of this study include the use of validated interviews to assess the different PEBs, the fact that we study a sample without an eating disorder diagnosis and that we included both men and women.

With this study, we show that LOC eating is an indicator of disordered eating-related psychopathology. Regardless of the PEB presented, it is the severity of LOC eating that better explains associated psychopathology in patients with obesity under bariatric surgery treatment. This study also found evidence for grazing, in its compulsive and non-compulsive subtypes, as PEBs in the spectrum of disordered eating and related psychopathology. Of note, the similarities between SBE and compulsive grazing, either in the associated severity of LOC eating and in psychological measures, highlight the clinical relevance of compulsive grazing in this sample. Non-compulsive grazing, on its end, generally showed lower scores in all the measures assessed. Together, our findings support the conceptualization of the different PEB, including grazing, on a continuous scale of LOC and psychopathology.

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1 **Tables**

Table 1- Characterization of the sample: socio-demographic and weigh-related variables.

	Pre-surgery (n=163) *n(%); M(S.D.)*	**Post-surgery (n=131)** *n(%); M(S.D.)*
Sociodemographic/clinical information		
Sex (male/female)	32(19.6)/131(80.4)	15(11.5)/116(88.5)
Age	41.03(11.39)	42.26 (9.87)
Marital status		
Single	39(23.9)	23(17.6)
Live with partner	100(61.3)	88(67.2)
Separated	19(11.7)	14(10.7)
Widowed	5(3.1)	6(4.6)
Education level		
Basic(4 years) or less	34(20.9)	25(19.1)
5-8 years	20(12.3)	30(22.9)
9-12 years	82(50.3)	59(45.0)
Graduate level	27(16.6)	17(13.0)
Employment situation		
Student	5(3.1)	4(3.1)
Unemployed	63(38.7)	34(26.0)
Employed	82(50.3)	81(61.8)
Retired	13(8.0)	7(5.3)

Table 1(cont.) **-** Characterization of the sample: socio-demographic and weigh-related variables.

	Pre-surgery (n=163) *n(%); M(S.D.)*	**Post-surgery (n=131)** *n(%); M(S.D.)*
Sociodemographic/clinical information		
Type of surgery		
Gastric band	-	3(2.3)
Gastric bypass	-	80(61.1)
Gastric sleeve	-	48(36.6)
Weight-related variables		
BMI_current	42.82(5.66)	29.80(5.95)
Months since surgery	-	26.32(10.18)
PTWL	-	32.10(11.76)
BMI change	-	14.37(6.23)
PEBMIL	-	76.37(26.37)
WR	-	5.28(12.40)
Number of patients presenting problematic eating behaviors		
OBE	18(11)	8(6.1)
SBE	13(8)	18(13.7)
Compulsive grazing	19(11.7)	18(13.7)
Non-compulsive grazing	22(13.5)	18(13.7)

Legend: BMI – Body Mass Index; PTWL – Percentage of Total Weight Lost; PEBMIL – Percentage of Excess BMI Lost; WR – Weight Regain; OBE – Objective Binge-eating episodes; SBE – Subjective Binge-eating episodes.

Table 2 – Comparison of the different eating episodes on loss of control eating and the different psychopathological variables assessed.

Eating Behavior	**OBE** *M (SD)*	**SBE** *M (SD)*	**Compulsive Grazing** *M (SD)*	**Non-Compulsive Grazing** *M (SD)*	***None*** *M (SD)*	***F statistic***	***Pairwise comparison (Sidak test)***	***Homogeneous subsets (REGWF)***
Sample size	*N=26*	*N=29*	*N=35*	*N=36*				
LOC total score	16.27 (3.14)	13.90 (3.82)	13.49 (3.06)	8.03 (4.97)	-	25.81**	All PEB>NCG; OBE>CG/NCG	S1: NCG S2:CG/SBE S3:SBE/OBE
Sample size	*N=27*	*N=28*	*N=25*	*N=28*	*N=186*			
TFEQ-R21						7.94**		
Uncontrolled eating	2.58 (.66)	2.20 (.71)	2.20 (.79)	2.03 (.58)	1.63 (.57)	20.21**	All PEB>none; OBE>NCG	S1:None S2:NCG/SBE/CG S3:SBE/CG/OBE

Table 2 (cont.) – Comparison of the different eating episodes on loss of control eating and the different psychopathological variables assessed.

Eating Behavior	**OBE** *M (SD)*	**SBE** *M (SD)*	**Compulsive Grazing** *M (SD)*	**Non-Compulsive Grazing** *M (SD)*	***None*** *M (SD)*	***F statistic***	***Pairwise comparison (Sidak test)***	***Homogeneous subsets (REGWF)***
Sample size	*N=27*	*N=28*	*N=25*	*N=28*	*N=186*			
TFEQ-R21†						7.94**		
Cognitive restriction‡	2.78 (.58)	2.98 (.51)	2.91 (.65)	2.95 (.52)	3.02 (.58)	1.11	-	-
Emotional eating‡	2.83 (.66)	2.39 (.98)	2.53 (.86)	2.13 (.78)	1.66 (.70)	23.10**	All PEB>none; OBE>NCG	S1:none S2:NCG/SBE/CG S3:SBE/CG/OBE

Table 2 (cont.) – Comparison of the different eating episodes on loss of control eating and the different psychopathological variables assessed.

Eating Behavior	**OBE** *M (SD)*	**SBE** *M (SD)*	**Compulsive Grazing** *M (SD)*	**Non-Compulsive Grazing** *M (SD)*	***None*** *M (SD)*	***F statistic***	***Pairwise comparison (Sidak test)***	***Homogeneous subsets (REGWF)***
Sample size	*N=27*	*N=28*	*N=25*	*N=28*	*N=186*			
ED-15†						4.45**		
Weight concern‡	3.28 (1.77)	2.75 (1.57)	2.65 (2.13)	1.85 (1.94)	1.81 (1.78)	5.91**	OBE >NCG/none	S1:none/NCG/CG/ S2:NCG/CG/SBE S3:CG/SBE/OBE
Eating concern‡	2.69 (1.14)	3.12 (1.32)	2.61 (1.33)	2.37 (1.58)	1.99 (1.44)	5.76**	SBE>none	S1:none/NCG/CG S2:NCG/CG/OBE/SBE

Table 2 (cont.) – Comparison of the different eating episodes on loss of control eating and the different psychopathological variables assessed.

Eating Behavior	**OBE** *M (SD)*	**SBE** *M (SD)*	**Compulsive Grazing** *M (SD)*	**Non-Compulsive Grazing** *M (SD)*	***None*** *M (SD)*	***F statistic***	***Pairwise comparison (Sidak test)***	***Homogeneous subsets (REGWF)***
Sample size	*N=27*	*N=28*	*N=25*	*N=28*	*N=186*			
Rep(eat)-Q†						13.15**		
Repetitive eating‡	2.04 (1.43)	1.65 (1.57)	1.83 (1.45)	1.71 (1.44)	.66 (.84)	18.34**	All PEB>none	S1:none S2:SBE/NCG/CG/OBE
Compulsive grazing‡	2.62 (1.58)	2.17 (1.67)	2.25 (1.64)	1.73 (1.57)	.69 (.94)	27.14**	All PEB>none	S1:none S2:NCG/SBE/CG/OBE
DASS†						2.87**		
Depression‡	7.04 (6.02)	6.29 (5.62)	5.72 (5.92)	4.14 (4.21)	4.12 (5.08)	2.93*	OBE>none	S1:none/NCG/CG/SBE S2:NCG/CG/SBE/OBE

Table 2 (cont.) – Comparison of the different eating episodes on loss of control eating and the different psychopathological variables assessed.

Eating Behavior	**OBE** *M (SD)*	**SBE** *M (SD)*	**Compulsive Grazing** *M (SD)*	**Non-Compulsive Grazing** *M (SD)*	***None*** *M (SD)*	***F statistic***	***Pairwise comparison (Sidak test)***	***Homogeneous subsets (REGWF)***
Sample size	*N=27*	*N=28*	*N=25*	*N=28*	*N=186*			
DASS†						2.87**		
Anxiety‡	7.15 (6.35)	5.61 (4.94)	6.04 (5.63)	5.04 (4.87)	4.11 (4.48)	3.21*	OBE>none	S1:none/NCG/SBE/CG S2:NCG/SBE/CG/OBE
Stress‡	9.63 (5.53)	8.43 (4.87)	9.16 (5.41)	6.79 (4.65)	5.69 (4.91)	6.78**	OBE/SBE /CG >none	S1:none/NCG S2:NCG/SBE/CG/OBE
UPPS – negative urgency	2.99 (0.53)	2.66 (0.57)	2.72 (0.60)	2.42 (0.73)	2.29 (0.63)	10.28***	OBE/SBE/CG> none; OBE>NCG	S1:none/NCG S2:NCG/SBE/CG S3:SBE/CG/OBE

Table 2 (cont.) – Comparison of the different eating episodes on loss of control eating and the different psychopathological variables assessed.

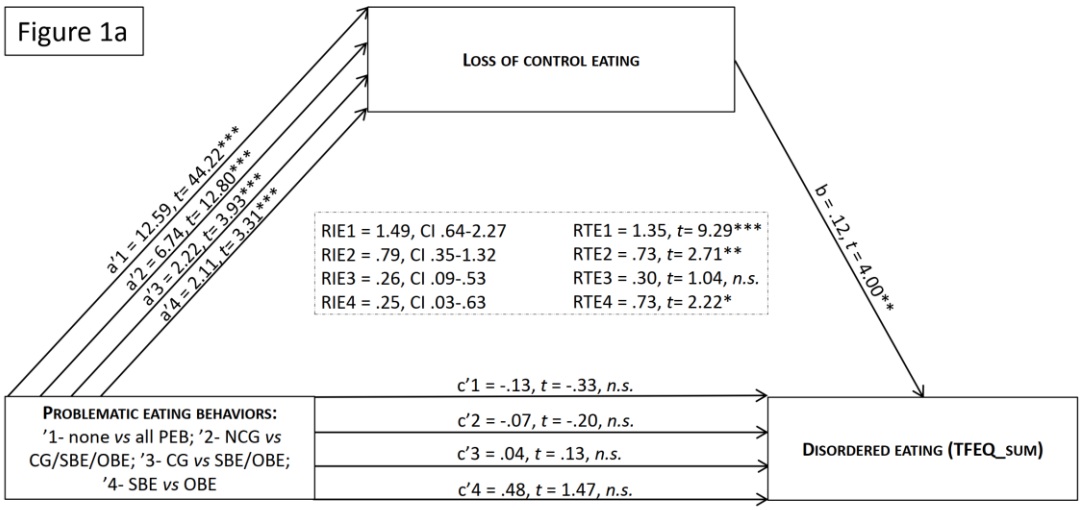
Legend: OBE – Objective Binge-eating Episodes; SBE – Subjective Binge-eating Episodes; LOC – Loss of Control Eating; none – no problematic eating behavior presented; TFEQ-R21 – Three Factor Eating Questionnaire; ED-15 – Eating Disorder-15; Rep(eat)-Q – Repetitive Eating Questionnaire; DASS – Depression, Anxiety a Stress Scales; UPPS - Urgency, Premeditation, Perseverance, and Sensation Seeking scales; †Multivariate statistics (Wilks' Lambda); ‡ Univariate test; *p<.05; **p<.001;

Figure legends

Figure 1 – The mediation role of loss of control (LOC) eating in the relation between problematic eating behaviors and a) disordered eating; b) eating disorder psychopathology; and, c) psychological distress. Mediation model with Helmert coding method.

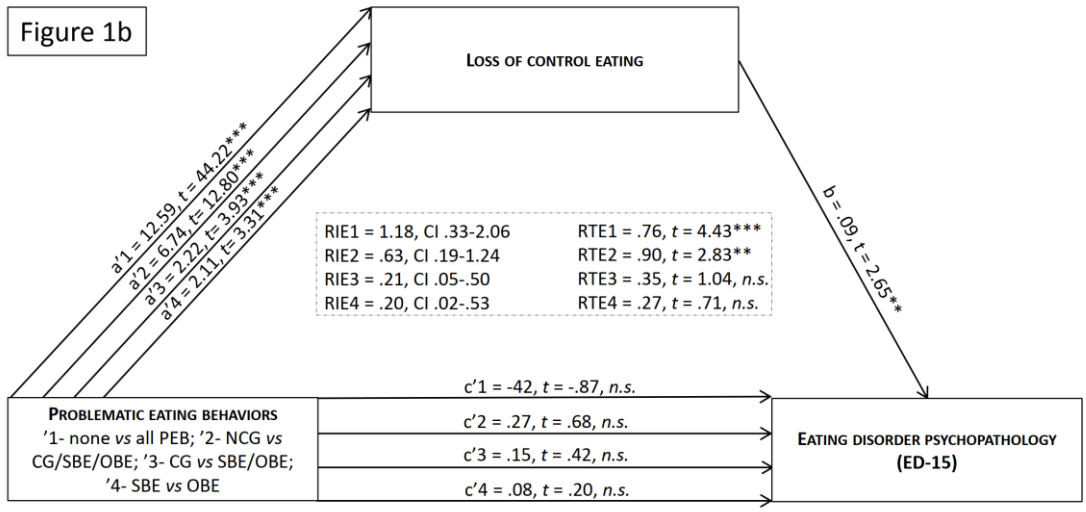
Legend Figure 1: OBE – Objective Binge-eating episodes; SBE – Subjective Binge-eating episodes; LOC – Loss of Control Eating; none – no problematic eating behavior presented; TFEQ_sum – sum of the Three Factor Eating Questionnaire subscales; ED-15 – Eating Disorder-15 total score; DASS_sum – sum of the Depression, Anxiety a Stress Scales. RIE – Relative Indirect Effect; RTE – Relative Total Effect. LOC eating is a full mediator in the relationship between problematic eating behavior and measures of psychopathology. Non-compulsive and compulsive grazing, subjective and objective binge eating are significantly associated with increasing severity of LOC eating. Greater LOC eating is significantly associated with greater scores in the psychopathological measures used. The indirect effect (thought LOC eating) of PEBs on psychopathology is significant. There is no evidence that PEBs are associated with psychopathology independently of their association with LOC eating.

Figure 1a



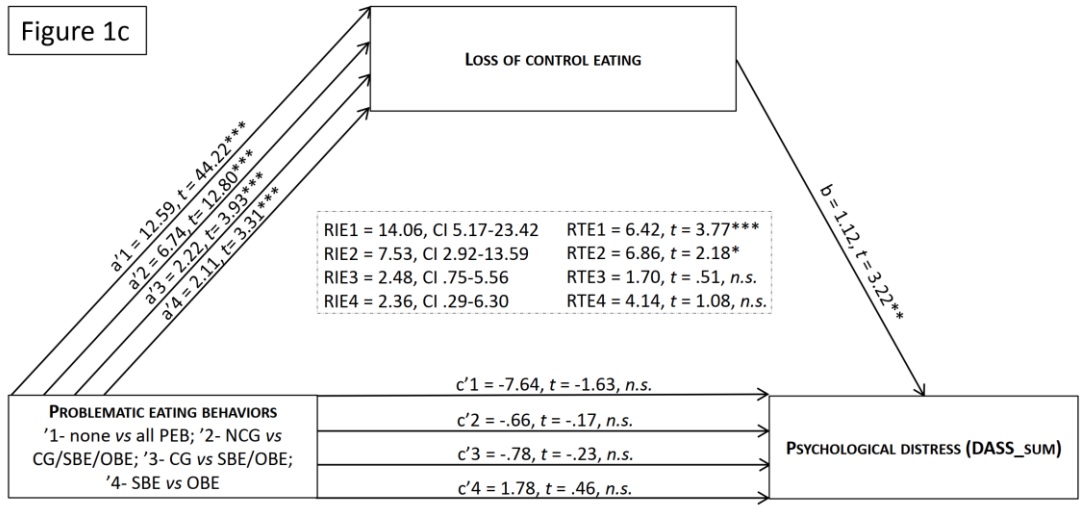
1

Figure 1b



2

Figure 1c



3